REMARKS

Claims 1-26 are pending in this application. No claims have been allowed. Claims 1-26 stand rejected. The Applicant has reviewed the Examiner's rejections in the Office Action mailed April 19, 2004, and now respectfully traverses the Examiner's rejections. Reconsideration and allowance of the pending claims are requested for the reasons detailed below.

35 U.S.C. § 102(b)

The Examiner rejected claims 1-26 under 35 U.S.C. § 102(b) as being anticipated by *Yan et al* ("Towards Flapping Wing Control for a Michromechanical Flying Insect," Dept of EECS, University of Cal Berkeley 2001). The Applicant respectfully traverses the Examiner's rejection.

1. Claims 1 and 14

The Examiner asserts, with respect to claims 1-26, that *Yan et al* "Basically shows all the features of the claimed invention including the details of specific waveforms and as the specifics are not there would be obvious in that they would be matters of engineering expepient (sic.)"

The publication by *Yan et al* discloses a control concept fundamentally different from the concept detailed in the apparatus of claim 1 and the method of claim 14. *Yan et al* seeks to achieve control over the vibratory wingbeat kinematics via the phasing of wing rotation and flapping motions through a force feedback control system. *Yan et al* relies on establishing a single resonant frequency for the wing that does not change during the running of the hardware. The drive mechanism used to excite the wing is then generated at this pre-calculated frequency. Because these resonant frequencies were calculated off-line, i.e. not in real-time while the hardware was operating, the actual resonant frequencies which were observed experimentally differed greatly from the pre-determined calculations.

Specifically, all prior art systems presume the existence of a pre-specified and invariant frequency for resonant excitation of the wing structure. This presumption precludes adaptation to changes in resonant frequency that may occur during operation as a result of flight at off-nominal conditions, wing damage, variation in flight speeds, or variation in ambient atmospheric conditions. As presented in claims 1 and 14 the present invention is a device and corresponding method which provide an *adaptive self-tuning* feature through a feedback control circuit that inherently tracks the resonant wingbeat frequency. This is a feature not found anywhere in the prior art.

The Applicant assumes that by stating, "*Yan et al* basically shows … the details of specific waveforms" the Examiner refers to *Yan et al*'s Figure 16: Force Tracking experiment. However, *Yan et al* is commanding a force and using feedback control to try to make the measured forces equal the commanded forces, the frequency of the commanded forces having been input a-priori. Figure 16 has nothing to do with closed-loop resonant tuning of the input excitation frequency.

The Applicant respectfully submits that *Yan et al* neither anticipates nor teaches the subject matter of claims 1 and 14. Claim 1 describes "a tuning circuit for enabling the excitation of a flexible structure at its resonant frequency, comprising a strain rate sensor configured for attachment to the flexible structure and capable of producing a feedback signal in response to the excitation of the flexible structure, a tuning algorithm capable of converting the feedback signal to a desired periodic waveform, and a first actuator capable of receiving the converted waveform and configured for exciting an oscillatory vibration of the flexible structure." The strain rate sensor attached to the flexible structure does not exist in *Yan et al*. The tuning algorithm, and the actuator responsive to that algorithm, is not present in *Yan et al*.

Likewise, Claim 14 describes "a method for maximizing the vibrational amplitude of a flexible structure, comprising the steps of exciting vibration of a flexible structure instrumented with a strain rate sensor capable of producing a feedback signal in response to the vibration of the flexible structure, converting the feedback signal to a desired periodic waveform, and re-exciting the flexible structure with a first actuator driven by the desired periodic waveform." *Yan et al* does not convert the feedback signal from a

strain rate sensor into a periodic waveform for re-exciting the flexible structure through an actuator.

Given the presence of the aforementioned elements in Claims 1 and 14 which are not present in *Yan et al*, the Applicant respectfully asserts that *Yan* does not anticipate the present invention, and further respectfully asserts that Claims 1 and 14 are therefore allowable.

2. Claims 2-13, and 15-26

Following from the Applicant's assertion above that claims 1 and 14 are allowable, the Applicant asserts that claims 2-13 which depend from claim 1, and claims 15-26 which depend on claim 14 are also allowable.

35 U.S.C. § 103

The Examiner rejected claims 1-26 under 35 U.S.C. § 103(a) as being unpatentable under 35 U.S.C. § 103(a) over *Yan et al.* The Applicant respectfully traverses the Examiner's rejection.

1. Claims 1 and 14

The Examiner asserts, with respect to claims 1-26, that *Yan et al* "Basically shows all the features of the claimed invention including the details of specific waveforms and as the specifics are not there would be obvious in that they would be matters of engineering expepient (sic.)" As argued above, *Yan et al* does not discuss, imply, or suggest the adaptive self-tuning that is the subject of the present invention.

The present invention solves a long felt and unsolved need. Inventors have been working in this field since at least 1993 (see Shimoyama, *Insect-Like Micro-robots with External Skeletons* IEEE Control Systems Magazine, 13:37-41, Feb. 1993). *Yan et al* divulges the difficulties associated with accurately calculating the resonant frequency of a flexible body in order to achieve control over the vibratory wingbeat kinematics. Eight years after the publication of *Shimoyama*, *Yan et al* still uses the practice of calculating

the resonant frequency of the body before the body is put in motion. The present invention eliminates the difficulties associated with the a-priori calculation of the resonant frequency by introducing a strain rate sensor and algorithm to monitor and calculate in real time the resonant frequency of the flexible body.

The principle on which the invention relies is also contrary to the teachings of the prior art. The prior art, for example *Yan et al*, operates under the premise that the system must be driven at a singular known and invariant resonant frequency. The present invention works on the principle that the resonant frequency of the flexible body changes while in operation. As claimed, the present invention uses the new principle to eliminate the calculation difficulties by providing a device and method for driving the system at the true current resonant frequency throughout operation.

In view of these observations, the Applicant respectfully submits that *Yan et al*, and other prior art, neither anticipates nor teaches the subject matter of claims 1 and 14. The prior art had difficulties calculating the proper resonating frequencies, and could not adjust to changing frequencies throughout operation; the present invention solves those problems. The principle that the present invention relies on, that the resonant frequency of the flexible body does not remain constant, is contrary to the teachings of the prior art. As the present invention provides a solution for a long-felt and unsolved need, and also relies on a principle contrary to the teachings of the prior art, clearly the present invention would not have been obvious to one skilled in the art. The Applicant therefore respectfully asserts that claims 1 and 14 are allowable.

2. Claims 2-13, and 15-26

Following from the Applicant's assertion above that claims 1 and 14 are allowable, the Applicant respectfully asserts that claims 2-13, which depend from claim 1, and claims 15-26, which depend on claim 14, are also allowable.

Response to Assertion of Pertinent Prior Art

The prior art made of record but not relied upon by the Examiner has been carefully reviewed. The Applicant submits that the prior art cited as pertinent to the

applicant's disclosure does not, either taken singly or in any reasonable combination with the other prior art of record, defeat the patentability of the present invention, nor does it render the present invention obvious. Further, the Applicant is in agreement with the Examiner that the prior art made of record but not applied does not appear to be material to the patentability of the claims currently pending in this application.

CONCLUSION

In view of the above Remarks, the Applicant submits that all pending claims in the instant application are in condition for allowance. Reconsideration and withdrawal of the objections and rejections is requested and allowance of the claims at an early date is solicited.

Respectfully submitted,

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